REMARKS

A marked-up copy of the above claims is attached showing the amendments by way of insertion and deletions.

Claim Rejections - 35 U.S.C. §112

The Examiner rejected Claims 15, 32 and 45 as being indefinite for lack of proper antecedent basis for the term "said bevel". Claims 14, 31 and 44 have consequently been amended to provide the necessary antecedents.

Claim Rejections - 35 U.S.C. §103

The Examiner rejected claims 1 - 6, 8 - 23 and 25 - 45 under 35 U.S.C. §103(a) as being unpatentable over Thornburn et al. (U.S. 4,193,440) in view of Kush (U.S. 5,363,902). Reconsideration and withdrawal of this rejection is requested for the following reasons.

The intent of the present invention is to improve the temperature control and guidance of a belt within the casting zone of a belt caster. It should be noted that effective temperature control means the maintenance of a consistent temperature gradient across the belt, and not the quenching or overall cooling down of the belt after use. This is achieved in the present invention by establishing the claimed features so that the coolant moves not only in a continuous layer in a longitudinal direction but is maintained at uniform thickness and velocity. This causes the belt to float at a fixed spacing ("stand off") on a liquid film over the supporting members with a highly uniform moving layer of coolant between the belt and the supports. The combined objectives of temperature control as well as guidance of the belt are thereby achieved.

Thorburn et al. was discussed in the response to the previous Office Action, and is concerned with a belt coolant and guidance system comprising many resilient supporting nozzles that have a central point coolant inlet and circumferential gap for coolant removal arranged around a hexagonal periphery of the nozzles. The hexagonal shape allows for closer packing of the nozzles. However, coolant flow is two-dimensional, i.e. entering at the central inlet and flowing in all directions outwardly to the peripheral coolant removal gap.

The Examiner first of all argued that the provision of specific slot and bevel dimensions is not inventive in that they represent routine variation and optimization. The specific slot dimensions are of course present in dependent claims, not in the main claims. They are what mark preferred embodiments of a caster cooling system according to the present invention after the coolant inlets and outlets have been made linear, so it is submitted that the Examiner should not consider them as optimizations of Thorburn et al. alone (as the Examiner appears to do) since the Examiner has not rejected the main claim with respect to Thorburn et al. alone. As admitted by the Examiner, Thorburn et al. does not disclose a slotted nozzle of any kind. With respect to the groove (Claim 12) and the bevel (Claim 14), these are geometric features rather than dimensions. The same comment applies as for dimensional variants, but additionally, neither of these features is taught by Thorburn et al. The closest that Thorburn et al. comes with respect to the feature in Claim 12 is the use of a `dish shape' which is not at all the same. Thorburn et al. is silent as to bevels at the edges adjacent the coolant removal slots. The routine optimization (of the structures disclosed in Thorburn et al.) suggested by the Examiner would not extend to features that are not even suggested by the prior art reference. These geometric features cause significant changes in the operating conditions of the caster as shown in Figure 7 of the present application, and are beyond routine optimization efforts.

The Examiner stated that Thorburn et al. describes a cooling and positioning system that contains all the elements of the present invention except for a continuous slot in the support surface arranged transversely substantially completely across the casting belt, as well as a vacuum system associated with the drainage opening. The Examiner then combined the teaching of Thorburn et al. with that of Kush, thereby adding a linear slot to replace the point source of the Thorburn nozzle, a linear slot to replace the hexagonal exit of the Thorburn nozzle and a vacuum system to remove coolant. As mentioned above and as noted in the response to the previous official action, the system of Thorburn et al. creates a two dimensional flow of coolant, with coolant moving outwards in all directions from a plurality of point sources, to be removed through hexagonal slots. That is to say, the coolant flows from the point source having a very small linear (circumferential) dimension to an exit having a relatively much larger linear (circumferential) dimension. This was found by Thorburn et al. to achieve a useful balance between hydrodynamic forces and the mechanical properties of the casting belt that maintained the belt at a specific position ("stand-off") from the underlying surface so that the belt floats over the underlying surface in a controllable manner. However, the temperature control lacks uniformity and is not as effective as desired.

Kush describes the application of coolant using a longitudinal slot arrangement with removal of the coolant via another slot. A vacuum system is used to assist in removing the coolant. Kush applies to a system for cooling a casting belt at a location remote from the casting cavity (see references 68 and 69 of Fig. 4 of Kush). The cooling system is in the form of a quenching box that applies a coolant spray against both sides of the belt, has evacuated drains on both sides of the belt, and applies both a containment fluid and a gas as part of the coolant containment at the ends of the box. The purpose of the vacuum in the Kush device is to remove the liquids and excess gas present so as to prevent

leakage outside the box surrounding the belt. The Kush device, in summary, is an apparatus to achieve effective cooling of a belt on a belt caster after the belt has passed through the casting cavity. Kush refers to the apparatus as a quenching system - i.e. for quickly cooling down a hot belt after it exists the casting region. In contrast to the present invention, it does not directly provide temperature control within the casting cavity and it is not concerned with maintaining the position of the belt, or supporting the belt, within the casting cavity or elsewhere.

In developing a system as presently claimed compared to that of Thorburn et al., one skilled in the art would have to change the direction of flow from a two-dimensional flow to one which is essentially one-dimensional, and to one in which the coolant flows from a source to an exit having linear dimensions that are equal while maintaining a useful belt stand-off and position control. Thorburn et al. does not suggest that this should be done nor provide any guidance as to how this could be done.

The question therefore arises as to whether Kush provides such a means or teaching. Kush teaches that a slot-like coolant source, a slot-like removal system and vacuum system is effective for cooling a belt in a belt caster when used remotely from the casting cavity in a "box" designed so that both sides of the casting belt can be exposed to coolant spray. Kush refers to this as a quenching process and not a temperature control method. There is nothing in the reference that would suggest that the technique would be effective for cooling if it were applied to only one side of the belt in the casting cavity, or that a "quenching" process would be effective at temperature control when applied to the casting cavity where a specific temperature gradient must be maintained through the casting belt. Furthermore, there is no suggestion that the arrangement would achieve a uniform and continuous layer of coolant between the belt and the supporting surface. Figure 3 of Kush suggests a general longitudinal flow of coolant, but does not illustrate that the coolant will flow in a

uniform and continuous layer. The reference provides no suggestion that the "linear" arrangement would result in a proper balance of hydrodynamic forces and belt mechanical properties required in the present invention and therefore one skilled in the art, starting with Thorburn et al., would not be motivated to change the nature of the coolant inlets and outlets to the linear arrangement of Kush since they would not know whether or not the careful balance of forces obtained using the Thorburn approach would survive such a change in the arrangement, or whether some new balance of forces equally acceptable for the performance of a belt caster could be achieved.

It should be noted that while Kush may teach a generally longitudinal coolant flow direction (Figure 3), there is nothing that teaches the uniformity required by the present invention. Merely because the belt appears to be symmetrically placed between the two sides of the cooling system does not mean that the coolant will have uniform thickness. In fact, Figure 3 of Kush illustrates what is more an impingement and bounce-off type of flow - albeit in a generally longitudinal direction - which is not consistent with achieving uniform thickness of flow. Moreover, Kush requires the use of a "containment fluid" (a gas) in addition to the cooling liquid, which has no part in the apparatus and method of the present invention. In fact, Kush tends to teach away from the present invention in suggesting that longitudinal slots create a non-uniform flow of coolant liquid over a moving surface (as shown by the arrows in Fig. 3), which is the opposite of that desired in the present invention.

Taken alone, Kush provides no solution to the problem of cooling the belt as it passes through the cavity since the quenching box, which directs spray at both sides of the belt, would not be adaptable to such a task and does not provide a solution for maintaining belt position in a casting cavity. Taken with Thorburn et al., the reference fails to teach that adding the linear slot to the particular nozzle arrangement used by Thorburn

et al. to achieve cooling and belt positioning would provide for improved cooling in a situation where one has to cool on one side of the belt only, nor would it provide for improved belt positioning, in that it does not address this problem at all.

It should be noted finally with respect to Kush, that this reference does not teach the usefulness of grooves or bevels either, so that the dependent claims containing these features would not be obvious from Thorburn et al. alone, or from Thorburn et al. in combination with Kush.

Most importantly, it would not be possible to combine the apparatus of Thorburn et al. with that of Kush to achieve the present invention. Kush requires access to both sides of the cooling belt for quenching, whereas Thorburn supports the belts in the casting cavity where there is access from only one side (the other side being in contact with cooling molten metal). Thorburn et al. must offer support and guidance for the belt, whereas Kush provides none. There is nothing in either reference to motive a person skilled in the art to consider a combination with the other. If Thorburn et al. and Kush were combined, it would be logical to use them in tandem since they address different problems, i.e. with the apparatus of Thorburn et al. providing temperature control and guidance of the belts in the casting cavity and the apparatus of Kush providing quenching of the return belt run. This combination does not amount to the present invention.

The combination of Thorburn et al. and Kush is therefore improper and could not lead to the present invention.

The Examiner further rejected claims 7 and 24 under 35 U.S.C. §103(a) as unpatentable over Thorburn et al. in view of Kush and further in view of Dumont-Fillon et al. (U.S. 3,799,239). Reconsideration and withdrawal of this rejection is also requested.

Claims 7 and 24 are dependent claims. Since the claims from which these claims depend are believed to be patentable over the

combination of Thorburn et al. and Kush for the reasons given above, it is believed that these claims should also be considered patentable over this combination and so the further citation of Dumont-Fillon is not relevant.

In view of the amendments made in this response and the arguments provided above, favorable reconsideration of this application is requested.

Respectfully submitted,

Christopher C. Dunham
Reg. No. 22,031
Attorney for Applicants
Tel. (212) 278-0400

I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to Assistant Commissioner for Patents, Washington, D.C. 20231.

Christopher C. Dunham, Reg. No. 22,031

Date AUGUST 6, 2002

Marked-up copy of the above claims showing the amendments by way of insertion and deletions

14. (Amended) The apparatus of claim 1, wherein said support surface is beveled away from said reverse surface at outer edges of said nozzle to form a bevel adjacent to each of said outer edges.

31. (Amended) The twin belt caster of claim 18, wherein said support surface is beveled away from said reverse surface at outer edges of said nozzle to form a bevel adjacent to each of said outer edges.

44. (Amended) The nozzle of claim 35, wherein said support surface is beveled away from said reverse surface at outer edges of said nozzle to form a bevel adjacent to each of said outer edges.